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On the biology and ecology of *Galba truncatula* Müll. and cercariae of *Fasciola hepatica* L. in basin of the river Barycz

Z badań nad biologią i ekologią *Galba truncatula* Müll. i cerkarii *Fasciola hepatica* L. w dorzeczu Baryczy

In 1953 the Parasitological Committee of the Polish Academy of Sciences undertook the task to combat pasture invasive diseases, particularly the fasciolosis. Among the numerous plans of the Parasitological Committee one of the first was the elaboration of a map of the distribution of *Galba truncatula* Müll. in Poland. Particular attention was paid to the terrains which were designated as fodder stores for collective farms set for animal breeding production and to the elaboration of the biology and ecology of the snail.

As the result of this action during the last years a number of works and communicates of Polish authors referring to *Galba truncatula* were written: Czapik et Węglarska (1954), Dróżdż et Malczewski (1956), Chowaniec (1956), Bednarz (1958), Drozdowski (1958), Chowaniec et Dróżdż (1959), Stefański (1953, 1954, 1955), Styczyńska-Jurewicz (1956, 1958). The works, however, having a fragmentary approach to the problem concerned with *Galba* do not give a full picture of its distribution in Poland.

The present work deals with a number of problems connected with *G. truncatula* and with cercariae of *F. hepatica* occurring in basin of the river Barycz. The studies were conducted since March, 1953 to autumn, 1957 and the work was aided by a subvention from the Parasitological Committee of the Polish Academy of Sciences.

Methods

On the terrains of the basin of the river Barycz I conducted searches which included possibly all water reservoirs, river beds and brook beds, boggy places and dampy areas, watering places, hoof-impressions on pasture grounds and meadows, ruts, road-side ditches, dampy terrains only in some periods of the time, it is in the spring and in autumn, after heavy and prolonged rainfalls. To collect the ecological data of *Galba* I controlled repeatedly its biotopes in the course of one vegetative season. From every biotope I collected about 30 — 50 *G. truncatula* to examine them for the larvae of *F. hepatica*. Besides *Galba* I collected also other snails such as *Limnaea stagnalis* L., *Stagnicola palustris* Müll., *Radix peregra* Müll., *Physa fontinalis* L., *Succinea* sp. sp., and *Planorbis* sp. sp.

To obtain a possibly accurate picture of fasciolosis of cattle in a given environment I collected samples of fresh faeces from domestic animals directly on the pasture grounds and cow-sheds and I examined them by the decantation method. I received great aid in my work from the population, who offered me valuable informations, and from the veterinary practitioners who many a time pointed to me the centres of particular increase of liver fluke disease.

General characteristic of the Barycz Valley

As regards melioration the pasture grounds of the Barycz valley are neglected. Generally Lower Silesia receives less rainfalls than Upper Silesia or the Cracow district, but more than the Poznań district. The climate of Lower Silesia is transitional between continental and oceanic cilmates, which brings once dry and the next time cold masses of air and causes few rainfalls. During some summers, however, the longlasting rains are the cause of floods. The winter lasts on the average 10 — 12 weeks (at the mean daily temperature 0°C.). The length of the vegetative period (at the mean daily temperature plus 5°C.) on both sides of the river Barycz lasts 31 — 32 weeks. The soil along the course of the river Barycz and on both its sides is that characteristic for valleys, mainly sandy, therefore of inferior quality.

In autumn, when the flood-gates of the fish-ponds are opened in connection with the catch of fishes, the water overflows the

naglected canals and ditches and instead of reaching directly the river Barycz and its contributary streams floods the forests, lands, meadows and pastures. This can also exert a negative effect on the problems of pasture invasive diseases, particularly on fasciolosis.

Bioecological data of *Galba truncatula* Müll.

From my observations conducted over the period of several years on *Galba truncatula* it appears that this snail occurs mainly in the vicinity of human dwellings and on their area depending on the presence of water reservoirs, water flowing through the terrains or other kind of hygrophilic environs. However, the snail does not occur on acid ground, in canals, dampy terrains and forest ditches.

Atkins' and Lebour's observations show that the vital optimum to the majority of snails is in water of pH 7 — 8, but to *Galba*, according to the same authors and according to Zadina and Pankratova, 1931 (cited after Skrjabin, 1948) this limit ranges from 6.1 to 8.05. Tarnohradskij and Popov report for the typical reservoirs of *Galba* in North Caucasus pH 5.8 — 9.0 and they state that at a lower or higher pH the snails live in a condition of drowsiness, and at pH 10 they die.

On the basis of my field studies I was able to differentiate two fundamental types of biotopes of *Galba:* permanent and periodical. To the first category I include biotopes which have a sufficient degree of moisture during the whole vegetative season, scarcity of other species of snails, sufficient insolation, ventilation, not-acid substratum, favourable configuration of the terrain, which protects the snail against displacement by the stream of water during spring and autumn and during heavy rainfalls. Biotopes of this type are found in place located in the vicinity of road-side ditches, melioration ditches on meadows and pastures, pools, watering places at springs, small depressions at larger isolated and open reservoirs, banks of slowly flowing streams, fish magazines, marginal areas of moors, dampy places near wells etc. I regard the permanent biotopes as the fundamental source of the liver fluke disease, because *Galba* finds in them the most favourable living conditions. Because those places are located in the vicinity of human dwellings or are enclosed by them, and because cattle visits them, the invasion can easily take place.

To the second type of biotopes of *Galba* belong such which arise after prolonged and continuous heavy rain-falls, particularly in the spring and autumn, when the level of water in rivers and reservoirs is considerably rised. Biotopes of this type are found on the river banks at the places of their contact with the water surface. Here belong also various kinds of slimy places, shallow waters of slow flow and all other biotopes which may get displaced owing to the movements of water. With the rise of the level of water during rainfalls the snails may get caught by the stream of water and may be transferred to other biotopes of a permanent or periodical character.

From the point of view of the problems of fasciolosis, the periodical type of biotope is unfavourable to the population of *Galba* in that the majority of the snails die during the passive transfer and the remaining number after regaining favourable living conditions regains possibilities for existence, but no for a longer period of time. On the other hand, the water movements break the centres of fasciolosis, but at the same time favour the spreading of it on large areas. At great masses of water the likehood of a contact of the miracidium with the snail is smaller than in small reservoirs or pools, in which the penetration of the miracidia is more favourable.

During the several years lasting studies I observed young and adult *Galba* creeping on the ground, plants, stones and various objects and very occasionally I found them on the bottom of reservoirs, even if they were shallow.

In the problems of the combat against liver fluke disease an important rank occupies the task to conduct correct melioration activities. Field observations show that the most practical way to dry dampy terrains is the use of a draining system instead of ditches which as a rule constitute favourable living conditions to *Galba*. In the newly dug ditches *Galba* remains and after a time, when the ditch becomes covered with slime and pooles are formed, the snails attain the peak of the numerical development. The vegetation becomes in such places very rich, and constitutes a good protection during a dry season and such a biotope is quite favourable for the snails to sustain the winter. Terrains with an installed draining system do not offer to snails such favourable living conditions.

As winter-places for *Galba* serve usually small imprints, depres-

sions in the terrain, traces after cattle hoofs. They are overgrown with plants or covered with dry grass, moss or other elements of organic origin, which offer a protection against a great drop of the temperature of the winter-place. In December 1956 I collected on the bank of the river Sieczka in Żmigród *Galba* at the outer temperature from minus 8 to 10°C. in the traces of hoofs. In the early spring next year (March, 1957), when the ground was still frozen and some places were still covered with snow I collected also the snails from this winter-places. At this time I found also other winter-places of *Galba* on the bank of the river Sieczka at the distance of about 30 cm from the water surface under the broken cover of ice; some of the snails were creeping, other were still immersed with their opening in the earth. In the early periods of spring studies I found barely few snails invaded with the larvae of *F. hepatica* in the biotopes which in the preceding period were strongly invaded. The invaded forms are in an alarmed state; the pathological condition is wasting their energy, therefore the considerable number of the snails does not sustain the first slight frosts and die. Keeping the invaded snails together with normal ones I observed that the first listed were on the whole more active. Besides this the invaded individuals usually had no chance to find favourable winter-places. These are the main causes which make for the majority of the invaded snails impossible to sustain the winter.

The highest percentage of the invaded snails in the studied period was recorded by the end of June and the first half of July, and in 1954 — by the end of July (prolonged winter, rainy and chilly spring). The next increase of invasion of snails was recorded in September.

The rain-falls cause a passive transfer of *Galba* and favour the break of biotopes and centres of invasion; on the other hand, drought increases considerably the mortality rate of the snails. In 1953 in Sułów, province Milicz, owing to the prolonged drought 70% of *Galba* died because of dryness. During the period of drought *Galba* hides in the crevices of the broken land, under plants, stones, in clefts of bridges on the rivers. During hot days *Galba* leaves the small water reservoirs which become overheated and deprived of oxygen; this phenomenon was corroborated by the studies of Chowaniec and Drożdż (1959). On the 3rd of October, 1957 I found in Kamieniec Wrocławski near Wrocław not before

rainfalls started an interesting biotope of *Galba*, which lies on the border of the terrains flooded with the municipal gutters. This terrain is separated from the cultivated land by a ditch overgrown with plants. In the ditch *Galba* occurred numerously, on the average 20 specimens per 1 square metre. This ditch most probably was intended to serve to take the excess of the contents of the gutters. By the end of October the same year, I noticed the presence of *Galba* on the adjacent cultivated land. This new biotope occupied a terrain lying about 10 m in radius from the centre of the original biotope. The snails occupied the traces left by hoofs, whereby in the traces there was some water and on the bottom there was animal manure. The case of the migration of the snails *Galba* onto cultivated land is harmful because the animal manure invaded with eggs of liver fluke becomes, under favourable conditions, the source of invasion of *Galba*. Besides, the water flowing from the land may carry also the eggs of *Fasciola hepatica* and transfer them on lower terrains which most commonly are the biotopes of *Galba*.

In the basin of the river Barycz I examined the terrain of 52 localities. In 48 of them I found biotopes of *Galba truncatula* Müll. The total number of the permanent and periodical biotopes on the terrain of those localities amounted to 109, whereby the number of the periodical residences was twice as large as that of the permanent ones. The area of every one of them was from 1 square metre to 100 square metres. The greatest concentration of biotopes was on terrains occupied by meadows, boggy pastures, small water reservoirs, draining canals and ditches, river and stream beds, and boggy terrains in the vicinity of water arteries. In barely several localities I found no *Galba* in spite of the positive coprological examination. This proves that the invasion reached the cattle by means of fodder obtained from invaded terrains or by means of adolescariae transferred with water. In spite of the similar configuration of the river or stream-bed on a larger section, the biotopes of *Galba* do not occupy the terrain in a continuous line. Among *Galba* there occurred also other snails: *Limnaea stagnalis* L., *Stagnicola palustris* Müll., *Radix peregra* Müll., *Succinea* sp. sp., *Physa fontinalis* L., and some snails of the family *Planorbidae;* however, they occurred always in very small numbers, and often as single specimens. I did not succeed to find in those snails the larval forms of *F. hepatica*. This fact is corroborated by many in-

vestigators and Wesenberg-Lund (l. c) is of the opinion, that the main intermediate host of *F. hepatica* under conditions of Central Europe is *Galba truncatula*.

At the moment when the residences of *Galba* become overgrown with the exuberant vegetation the snails climb on the plants because of the hindered access and exchange of air and dark conditions reigning in the biotope.

A case of a passive transfer of *Galba* was observed by me in one of the biotopes (Sanie), which on the next spring season diasappeared completely and its place was occupied by population of *Radix peregra* Müll. Because after the disappearance of *Galba* I found no subfossile material, which would prove the mass death of the whole population, I presume that the sole cause of this phenomenon was the passive transfer of the snails. This type of phenomena was observed also by Drozdowski (1958) in the Bydgoszcz district.

The size of *Galba* invaded with larvae of *F. hepatica* varied considerably. Most commonly the adult forms, measuring 4 mm and more, were invaded. Below this size I never found invaded snails. Chowaniec et Drożdż (1959) proved on the basis of experiments conducted by them that snails, measuring from 3 — 6 mm, are most susceptible to invasion, and that the forms measuring 1 — 2 mm die after invasion with miracidia of liver fluke.

The material collected in the investigation period proved that the mean invasion of *Galba* in the basin of the river Barycz was 15%, and that of cattle — 27,5%. These data do not reflect distinctly the real picture of fasciolosis on the examined terrain, because they were collected in various seasons of several years. Besides this, depending on the climatic conditions, the data are from year to year variable.

Conclusions

(1) The period of the occurrence of *Galba truncatula* is variable and depends on climatic and ecological conditions. After wintering the earliest occurrence of *Galba* was in March, the latest — in December.

(2) I found *Galba* invaded with larvae of *Fasciola hepatica* at the earliest by the end of June. The invasion persisted during the first two decades of July and next in September.

(3) In the majority *G. truncatula*, invaded with the larvae of *F. hepatica*, show greater motility than the forms free from the invasion; the restlessness caused by the pathological process acts wastingly on their energy and therefore it decreases their chance to sustain winter.

(4) The winter-places of *G. truncatula* lie outside the water reservoirs, that is on the terrains bordering with them.

(5) *G. truncatula* occurs in two types of biotopes: permanent and periodical. In the basin of the river Barycz there are twice as much periodical biotopes than permanent ones.

(6) The increased flow of water in spring and autumn and heavy prolonged rains cause a break of biotopes of *G. truncatula* and thus favour the spreading of the liver fluke disease.

(7) The biotopes of *G. truncatula* are in the majority located in the vicinity of human dwellings; this creates a greater danger of the spreading of liver fluke disease among the domestic animals.

(8) *G. truncatula* is a rather terrestrial than aquatic snail.

(9) *G. truncatula* does not occur on acid terains, therefore it is not found on peat-bogs, water reservoirs, ditches and canals in forests.

(10) *G. truncatula*, under special conditions, is capable to migrate on the adjacent cultivated fields which, when fertilized with animal manure, may become the source of invasion of the snails.

(11) Except *G. truncatula* no other snails were found to be invaded with the larvae of *F. hepatica*.

(12) The vegetation plays for *G. truncatula* a fundamental role in the winter season and during long lasting droughts as a shelter, and partly it constitutes also its food.

(13) The majority of biotopes of *G. truncatula* occupy small areas from 1 square metre to 100 square metres; only in certain cases (large shoals near the coast and secondary river beds) the area may be larger.

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STRESZCZENIE

Autor przeprowadzał badania nad biologią i ekologią *Galba truncatula* Müll. i cerkarii *Fasciola hepatica* L. w dorzeczu rzeki Baryczy (Dolny Śląsk) w okresie od marca 1953 r. do jesieni 1957 r. W wyniku tych badań zostało zbadanych 52 miejscowości, z których w 48 stwierdzono siedliska *G. truncatula*. Autor dzieli siedliska tego ślimaka na dwa typy: stałe i okresowe, przy czym łączna ich ilość w dorzeczu Baryczy wynosiła 109. Średnie zarażenie błotniarek moczarowych w tym czasie wynosiło 15%, bydła zaś — 27,5%.

U ślimaków współżyjących z *G. truncatula*, jak: *Limnaea stagnalis* L., *Stagnicola palustris* Müll., *Radix peregra* Müll., *Succinea* sp. sp., *Physa fontinalis* L. i u form z rodziny *Planorbidae*, ani razu nie stwierdzono obecności form larwalnych *F. hepatica*. Najwcześniejszy pojaw *G. truncatula* notowano w marcu, a najpóźniejszy w grudniu, przy czym okres ten, według autora, jest zmienny i zależy od warunków klimatycznych, w szczególności od temperatury i charakteru siedliska. Ponadto autor podaje szereg danych bioekologicznych o *G. truncatula*.